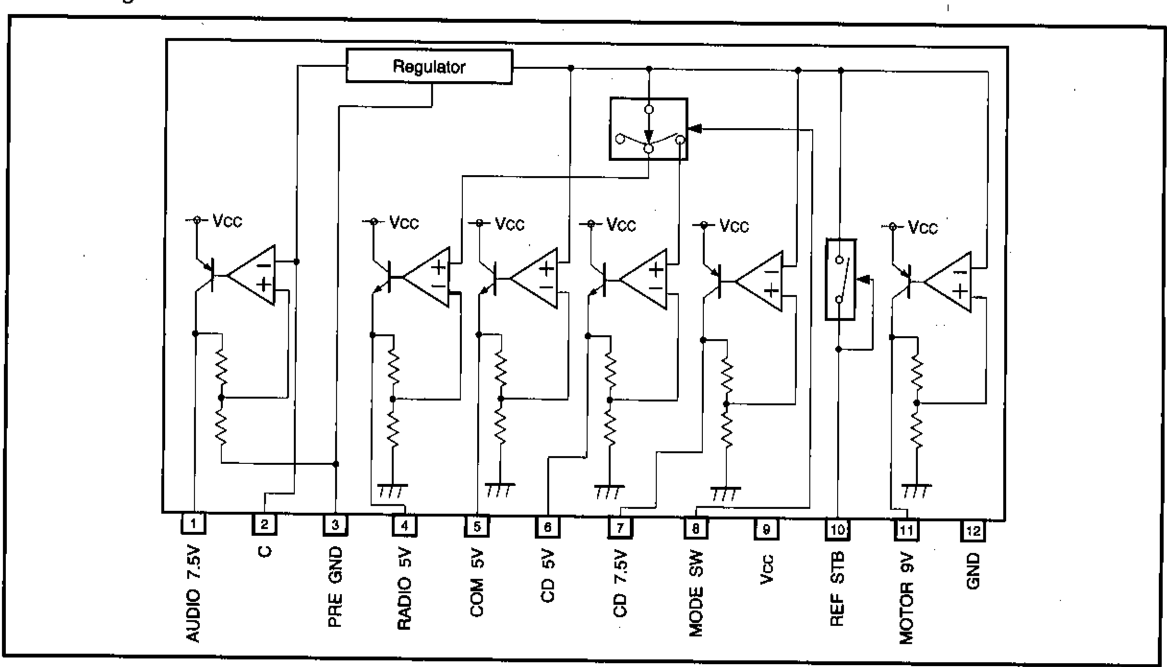
Reference voltage power supply
BA3933

The BA3933 is a monolithic reference voltage power supply IC for use in CD radio cassette players.

●Applications
CD radio cassette players, mini-component stereo audio systems

●Features
1) With 7.5V output for audio power supply, 5.0V output for microcontrollers, 5.0 and 7.5V outputs for CD players, 9V output for motor drivers, the IC is best suited for CD radio cassette players.
2) Precise power supply (5V ± 0.1V) can be obtained by using external reference voltage input (only AUDIO output has an internal reference voltage system).
3) Zero standby current. (Typ.)
4) Output current limit circuit protects the IC against short-circuiting damage.
5) Compact SIP-M12 package allows a large power dissipation (3W: no heat sink).
6) Thermal protection circuit prevents heat damage to the IC.

●Block diagram



●Pin descriptions

Pin No.	Pin name	Function
1	AUDIO 7.5V	AUDIO 7.5 V output pin
2	C	Pin to connect a capacitor that regulates AUDIO 7.5 V
3	PRE GND	AUDIO system GND
4	RADIO 5V	RADIO 5 V output pin; output when MODE SW is 1.4 V (typical)
5	COM 5V	Microcontroller 5 V output pin
6	CD 5V	CD 5 V output pin; output when MODE SW is 3.2 V (typical)
7	CD 7.5V	CD 7.5 V output pin
8	MODE SW	Pin to select CD 5 V, CD 7.5 V, or RADIO 5 V
9	Vcc	Power supply voltage.
10	REF STB	Reference voltage 5 V output pin; also a standby SW pin
11	MOTOR 9V	MOTOR 9 V output pin
12	GND	Large current GND, connected to the IC substrate

●Absolute maximum ratings (Ta=25℃)

Parameter	Symbol	Limits	Unit
Applied voltage	Vcc	23	V
Power dissipation	Pd	3000*1	mW
Operating temperature	Topr	−25~75	℃
Storage temperature	Tstg	−55~150	℃

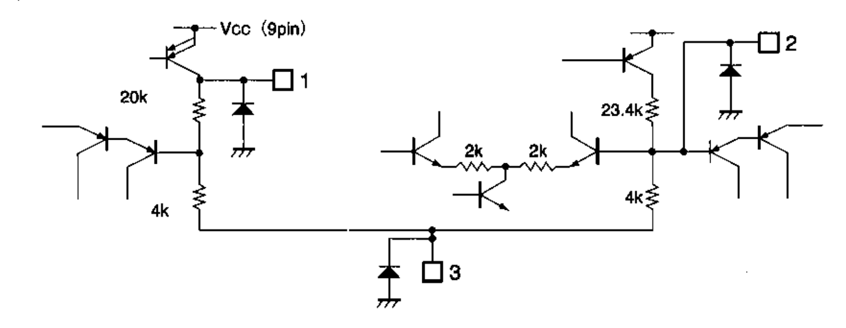
*1 Reduce power by 24mW for each degree above 25℃.

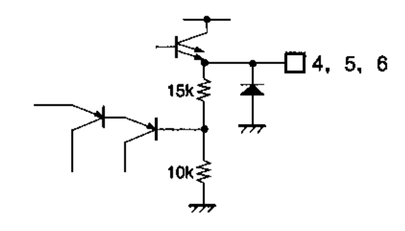
●Recommended operating conditions (Topr=−25 to70℃)

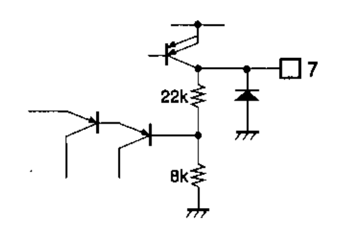
Parameter	Symbol	Limits	Unit
Operating power supply voltage	Vcc	6.5~22.0*2	V

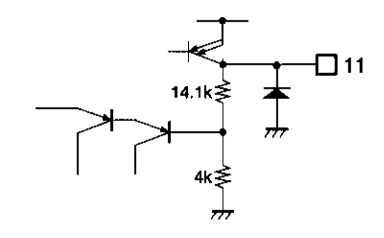
*2 Basic operation should be functional at Ta = 25 ℃.

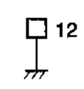
● Input / output circuits

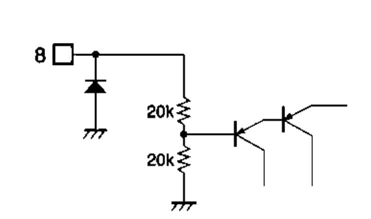


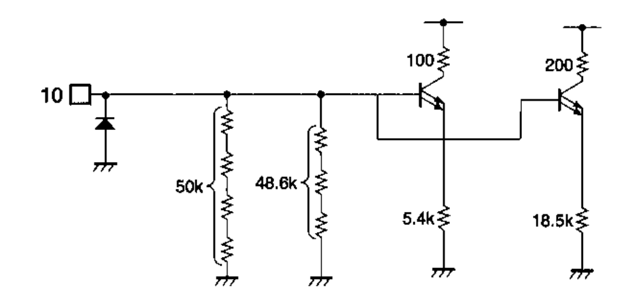












●Electrical characteristics (unless otherwise noted, Ta=25℃ and V_{CC}=16.0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Standby circuit current	I_{ST}	—	0	10	μA	STAND BY pin = 0 V
Output voltage (AUDIO 7.5 V)	V_{O1}	7.0	7.5	8.0	V	I_{O1}=250mA
Voltage variation	ΔV_{O11}	—	40	200	mV	V_{CC}=11V~22V I_{O1}=250mA
Load variation	ΔV_{O12}	—	30	200	mV	I_{O1}=0~250mA
Minimum I/O voltage differential *	ΔV_{O13}	—	1.1	2.1	V	I_{O1}=250mA
Output current capacity Note	I_{O1}	350	710	—	mA	V_{O1}≧7.0V
Ripple rejection ratio	R.R1	50	60	—	dB	f=100Hz V_{RR}=−10dBV
Output voltage (MOTOR 9.0 V)	V_{O2}	8.4	9.0	9.6	V	I_{O2}=600mA
Voltage variation	ΔV_{O21}	—	50	200	mV	V_{CC}=11~22V I_{O2}=600mA
Load variation	ΔV_{O22}	—	150	600	mV	I_{O2}=0~600mA
Minimum I/O voltage differential *	ΔV_{O23}	—	0.5	0.9	V	I_{O2}=600mA
Output current capacity	I_{O2}	1.2	1.4	—	A	V_{O2}≧8.4V
Output voltage (CD 7.5 V)	V_{O3}	7.0	7.5	8.0	V	I_{O3}=400mA
Voltage variation	ΔV_{O31}	—	20	200	mV	V_{CC}=8.5~22V I_{O3}=400mA
Load variation	ΔV_{O32}	—	70	250	mV	I_{O3}=0~400mA
Minimum I/O voltage differential *	ΔV_{O33}	—	0.3	1.0	V	I_{O3}=400mA
Output current capacity	I_{O3}	1.0	1.2	—	A	V_{O3}≧7.0V
Ripple rejection ratio	R.R3	40	60	—	dB	f=100Hz V_{RR}=−10dBV
Output voltage (CD 5 V)	V_{O4}	4.90	5.0	5.10	V	I_{O4}=180mA
Voltage variation	ΔV_{O41}	—	20	200	mV	V_{CC}=6.5~22V I_{O4}=180mA
Load variation	ΔV_{O42}	—	20	200	mV	I_{O4}=0~180mA
Minimum I/O voltage differential *	ΔV_{O43}	—	1.0	1.5	V	I_{O4}=180mA
Output current capacity	I_{O4}	220	400	—	mA	V_{O4}≧4.90V
Ripple rejection ratio	R.R4	50	60	—	dB	f=100Hz V_{RR}=−10dBV
Output voltage (RADIO 5 V)	V_{O5}	4.90	5.0	5.10	V	I_{O5}=80mA
Voltage variation	ΔV_{O51}	—	20	200	mV	V_{CC}=6.5~22V I_{O5}=80mA
Load variation	ΔV_{O52}	—	20	200	mV	I_{O5}=0~80mA
Minimum I/O voltage differential *	ΔV_{O53}	—	0.8	1.5	V	I_{O5}=80mA
Output current capacity	I_{O5}	100	220	—	mA	V_{O5}≧4.90V
Ripple rejection ratio	R.R5	50	68	—	dB	f=100Hz V_{RR}=−10dB

(unless otherwise noted, Ta=25℃ and Vcc=16.0V)

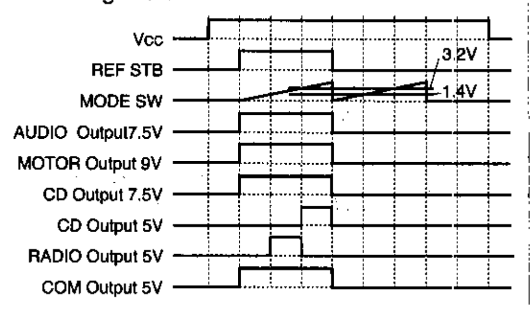
Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Output voltage (COM 5 V)	V_{O6}	4.90	5.0	5.10	V	I_{O6}=180mA
Voltage variation	V_{O61}	—	20	200	mV	V_{CC}=6.5~22V I_{O6}=180mA
Load variation	V_{O62}	—	20	200	mV	I_{O6}=0~180mA
Minimum I/O voltage differential *	V_{O63}	—	1.0	1.5	V	I_{O6}=180mA
Output current capacity	I_{O6}	220	400	—	mA	V_{O6}≧4.90V
Ripple rejection ratio	R.R6	50	60	—	dB	f=100Hz V_{RR}=−10dBV
Input (MODE SW)						
Voltage when RADIO MODE ON	V_{MTHH}	1.1	1.4	1.7	V	RADIO output voltage when switched to HIGH
Voltage when RADIO MODE OFF	V_{MTHL}	2.9	3.2	3.5	V	RADIO output voltage when switched to LOW
Voltage when CD MODE ON	V_{RTHH}	2.9	3.2	3.5	V	CD 5 V output voltage when switched to HIGH
Input current when HIGH	I_{IH1}	50	110	200	μA	MODE SW pin = 5 V
Input (REF STB)						
Input current when HIGH	I_{REF}	—	210	500	μA	REF=5V STAND BY pin = 5 V
Output voltage differential for each 5 V system	V_{DEF}	—	0	0.25	V	

◎ Not designed to be radiation tolerant.

* : Minimum I/O voltage differential refers to the difference between input and output voltage when Vcc is set to the minimum output voltage.

● Circuit operation

1. Timing chart



AUDIO 7.5V, MOTOR 9V, and COM 5V are output regardless of MODE SW.
RADIO 5V rises when MODE SW is 1.4V (typical), and CD 5V rises when MODE SW is 3.2V (typical).

2. Rough estimation of IC power dissipation
Except under transitional conditions, the power dissipation of this IC is 3W per unit at 25℃. See Fig. 4 for heat reduction characteristics, including some cases where heat sinks are used.

● Heat reduction characteristics

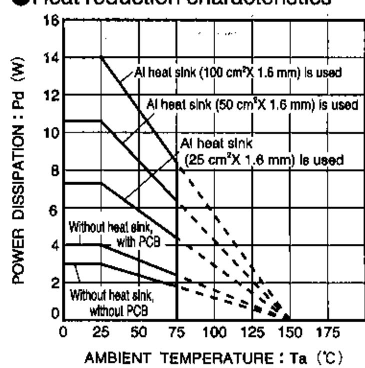


Fig.1 Heat reduction curves

●Circuit operation

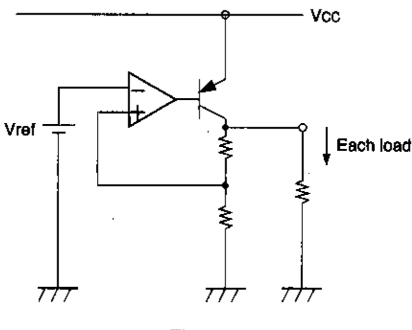


Fig.2

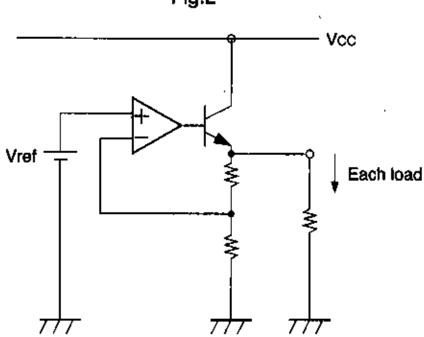


Fig.3

Calculation of P_{MAX}

• Power consumed by AUDIO 7.5V

$P_1 = (V_{CC} - 7.5V) \times I_1$

• Power consumed by MOTOR 9V

$P_2 = (V_{CC} - 9V) \times I_2$

• Power consumed by CD 7.5V

$P_3 = (V_{CC} - 7.5V) \times I_3$

• Power consumed by CD 5.0V

$P_4 = (V_{CC} - 5.0V) \times I_4$

• Power consumed by RADIO 5.0V

$P_5 = (V_{CC} - 5.0V) \times I_5$

• Power consumed by COM 5.0V

$P_6 = (V_{CC} - 5.0V) \times I_6$

• Power consumed internally by each circuit

$P_7 = V_{CC} \times$ circuit current

I_1 = maximum output current for AUDIO 7.5V
I_2 = maximum output current for MOTOR 9V
I_3 = maximum output current for CD 7.5V
I_4 = maximum output current for CD 5.0V
I_5 = maximum output current for RADIO 5.0V
I_6 = maximum output current for COM 5.0V

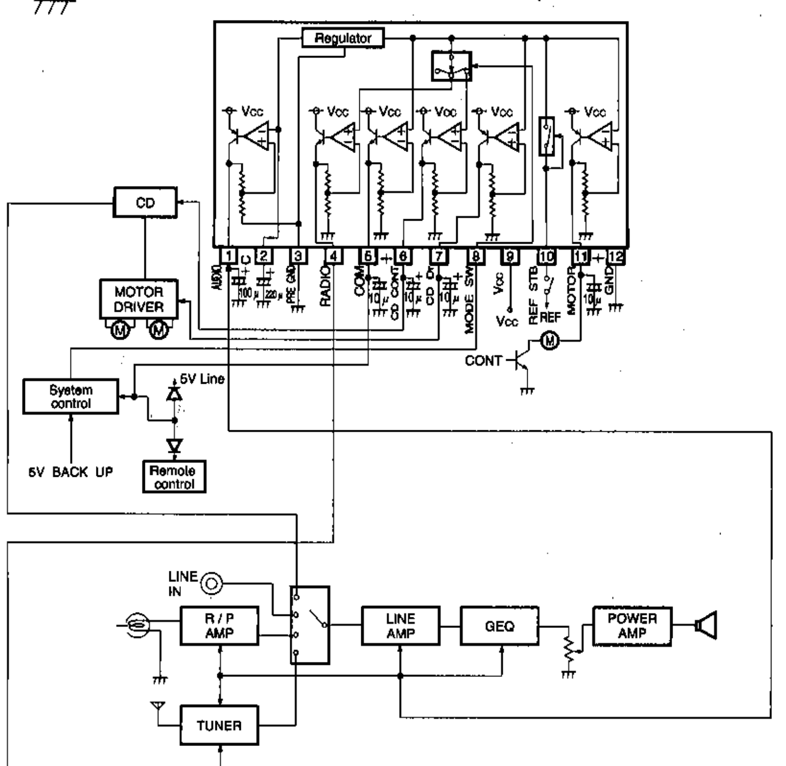


Fig.4

●Operation notes

1. Operating power supply
   When operating within proper ranges of power supply voltage and ambient temperature, most circuit functions are guaranteed. Although the rated values of electrical characteristics cannot be absolutely guaranteed, characteristic values do not change drastically within the proper ranges.
2. Power dissipation (Pd)
   Refer to the heat reduction characteristics and the rough estimation of IC power dissipation given on a separate pages. Make sure to use the IC within the allowable power dissipation with a sufficient margin.
3. Preventing oscillation at each output and installing a ripple filter capacitor.
   To stop oscillation of output, make sure to connect a capacitor between GND and each of the AUDIO 7.5V (pin 1), RADIO (pin 4), COM (pin 5), CD 5V (pin 6), CD 7.5V (pin 7), and MOTOR 9V (pin 11) output pins. We recommend using a tantalum electrolytic capacitor having a capacitance of 10 μF or greater (100 μF or greater for AUDIO 7.5V) with minimal temperature susceptibility. Also, sudden deterioration of the AUDIO 7.5V ripple rejection during a power drop can be prevented by connecting a capacitor (220 μF or greater recommended) to the C pin (pin 2).
4. Overcurrent protection circuit
   An overcurrent protection circuit is installed on the AUDIO 7.5V (pin 1), RADIO (pin 4), COM (pin 5), CD 5V (pin 6), CD 7.5V (pin 7), and MOTOR 9V (pin 11) outputs, based on the respective output current. This prevents IC destruction by overcurrent, by limiting the current with a curve shape of "7" in the voltage-current graph. The IC is designed with margins so that current flow will be restricted and latching will be prevented even if alarge current suddenly flows through a large capacitor. Note that these protection circuits are only good for preventing damage from sudden accidents. Make sure your design does not cause the protection circuit to operate continuously under transitional conditions (for instance, if output is clamped at 1V_F or higher, short mode circuit operates at 1V_F or lower).
5. Reference voltage
   Because output voltage is dependent on the input reference voltage, unstable input results in output wavering and degradation of ripple rejection. Take care when setting the reference voltage power supply. Note that the AUDIO output, which has a built-in reference voltage system, is not affected by the external reference voltage.
6. Thermal protection circuit
   A built-in thermal protection circuit prevents thermal damage to the IC. All outputs except V_{DD} are switched OFF when the circuit operates, and revert to the original state when temperature drops to a certain level.
7. Grounding
   Each ground line in the application circuit must be adequately short regarding the PREGND (pin 3) and GND (pin 12) pins. Make sure to arrange the ground lines, the AUDIO system, and other outputs in a pattern that prevents electric interference.

●Measurement data

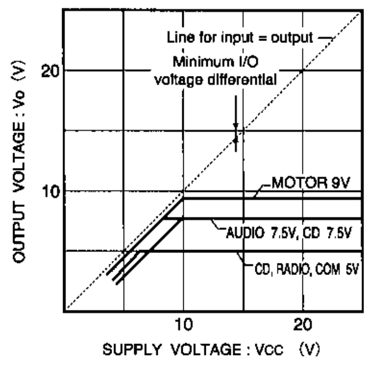
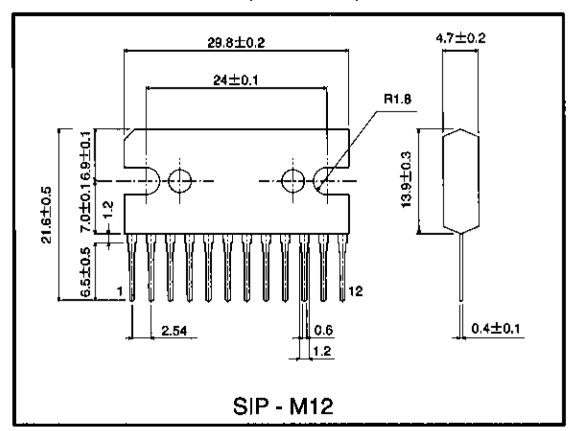


Fig.5 Thermal derating

●External dimensions (Units: mm)



SIP - M12